



**MOTOROLA**

# SEMICONDUCTORS

P.O. BOX 20912 • PHOENIX, ARIZONA 85036

## The RF Line

### NPN SILICON MICROWAVE POWER TRANSISTOR

... designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc  
Output power = 1.0 Watt  
Minimum Gain = 8.5 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CEO}$	20	Vdc
Collector-Base Voltage	$V_{CBO}$	45	Vdc
Emitter-Base Voltage	$V_{EBO}$	4.0	Vdc
Collector-Current — Continuous	$I_C$	250	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above $25^\circ\text{C}$	$P_D$	7.0 40	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +200	$^\circ\text{C}$

### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	$^\circ\text{C}/\text{W}$

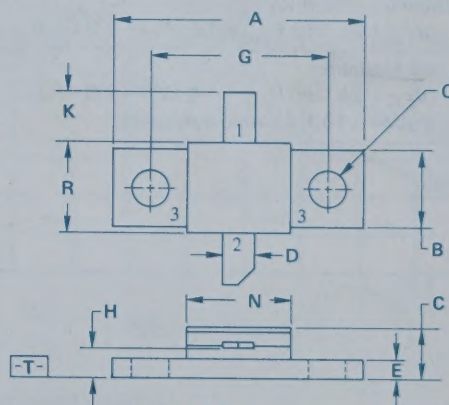
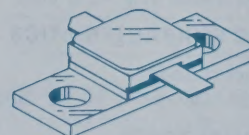
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# MRF2001M

1.0 W 2 GHz

### MICROWAVE POWER TRANSISTOR

NPN SILICON



STYLE 1:  
PIN 1. EMITTER  
2. COLLECTOR  
3. BASE

- NOTES:
1. DIMENSIONS  $\boxed{A}$  AND  $\boxed{B}$  ARE DATUMS.
  2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:  
 $\boxed{\varnothing 0.13(0.005)} \boxed{M} \boxed{T} \boxed{A} \boxed{M} \boxed{B} \boxed{M}$
  3.  $\boxed{-T-}$  IS SEATING PLANE.
  4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

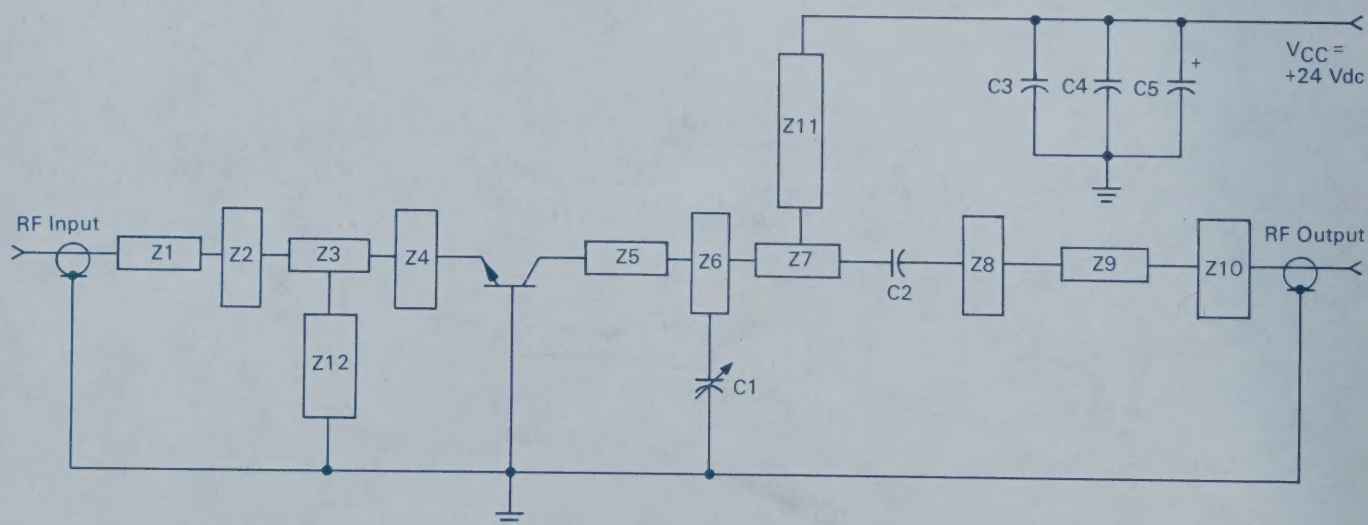
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Collector-Emitter Breakdown Voltage ( $I_C = 5.0\text{ mA}$ , $I_B = 0$ )	$BV_{CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ( $I_C = 5.0\text{ mA}$ , $V_{BE} = 0$ )	$BV_{CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ( $I_C = 5.0\text{ mA}$ , $I_E = 0$ )	$BV_{CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ( $I_E = 1.0\text{ mA}$ , $I_C = 0$ )	$BV_{EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ( $V_{CB} = 28\text{ Vdc}$ , $I_E = 0$ )	$I_{CBO}$	—	—	0.5	mA
<b>ON CHARACTERISTICS</b>					
DC Current Gain ( $I_C = 100\text{ mA}$ , $V_{CE} = 5.0\text{ Vdc}$ )	$h_{FE}$	10	—	100	—
<b>DYNAMIC CHARACTERISTICS</b>					
Output Capacitance ( $V_{CB} = 24\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )	$C_{ob}$	—	4.0	6.0	pF
<b>FUNCTIONAL TESTS</b>					
Common-Base Amplifier Power Gain ( $V_{CC} = 24\text{ Vdc}$ , $P_{out} = 1.0\text{ W}$ , $f = 2.0\text{ GHz}$ )	$G_{PB}$	8.5	9.5	—	dB
Collector Efficiency ( $V_{CC} = 24\text{ Vdc}$ , $P_{out} = 1.0\text{ W}$ , $f = 2.0\text{ GHz}$ )	$\eta$	35	40		
Load Mismatch ( $V_{CC} = 24\text{ Vdc}$ , $P_{out} = 1.0\text{ W}$ , $f = 2.0\text{ GHz}$ , VSWR = 10:1 All Phase Angles)	$\psi$	No Degradation in Power Output			

FIGURE 1 — 2.0 GHz TEST CIRCUIT



Z1-Z12 — Microstrip, See Photomaster  
 C1 — 0.6–4.5 pF Johanson 7271  
 C2, C3 — 56 pF Chip Capacitor  
 C4 — 0.1  $\mu\text{F}$   
 C5 — 10  $\mu\text{F}$ , 35 V  
 Board Material — 0.0312" Teflon Fiberglass  
 $\epsilon_r = 2.5 \pm 0.05$



FIGURE 2 — OUTPUT POWER versus INPUT POWER  
( $f = 1.7$  GHz)

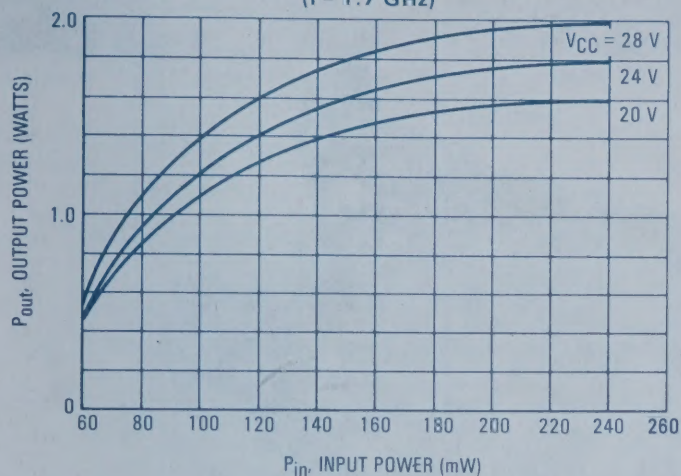


FIGURE 3 — OUTPUT POWER versus INPUT POWER  
( $f = 2.0$  GHz)

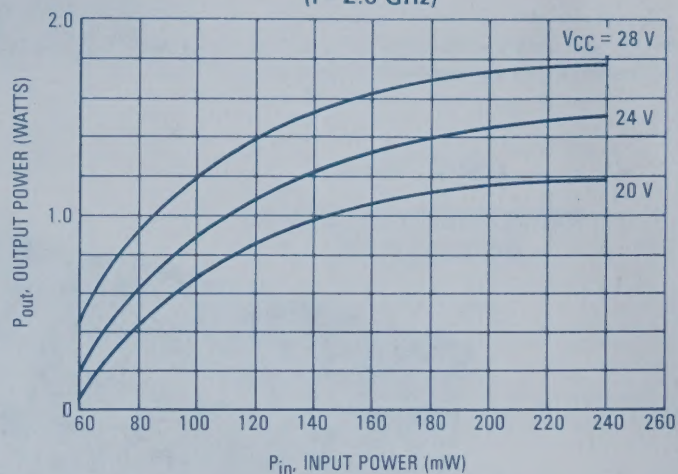


FIGURE 4 — OUTPUT POWER versus INPUT POWER  
( $f = 2.3$  GHz)

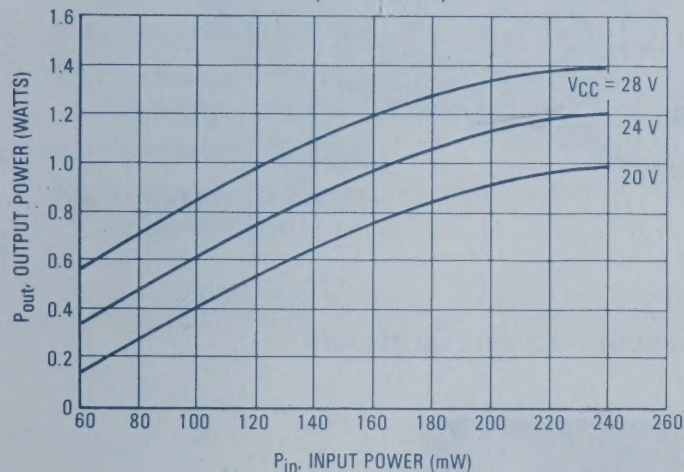


FIGURE 5 — POWER GAIN versus FREQUENCY

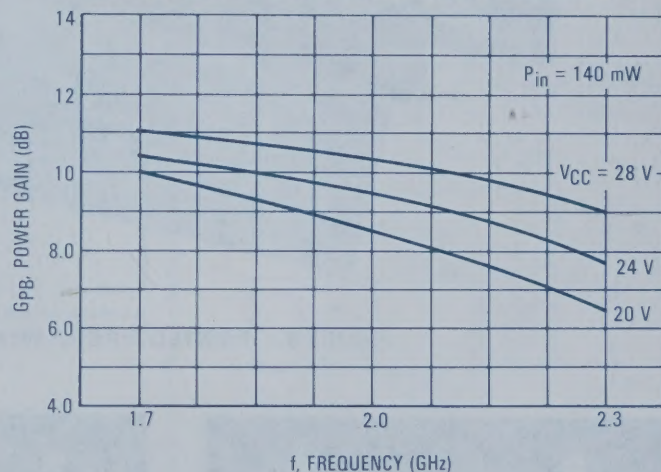
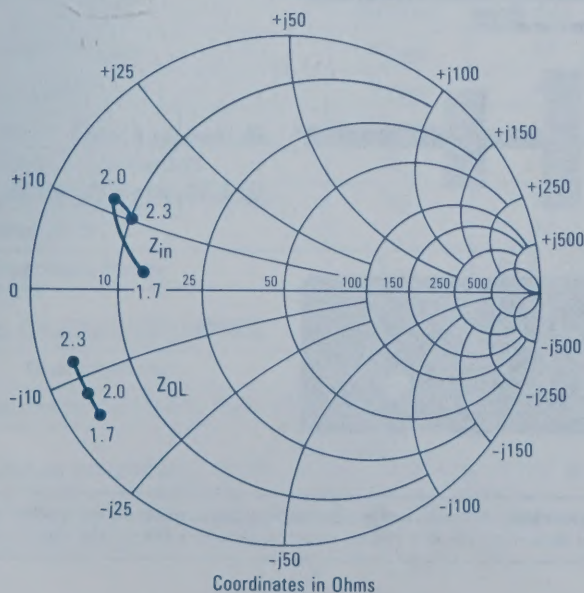


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



$V_{CC} = 24$  V,  $P_{in} = 140$  mW

$f$ GHz	$Z_{in}$ Ohms	$Z_{OL}^*$ Ohms
1.7	$15.5 + j 3.0$	$4.5 - j15.0$
2.0	$7.5 + j11.0$	$4.0 - j12.0$
2.3	$10.0 + j10.0$	$3.0 - j 7.0$

\* $Z_{OL}$  = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



FIGURE 7 — 2 GHz TEST AMPLIFIER

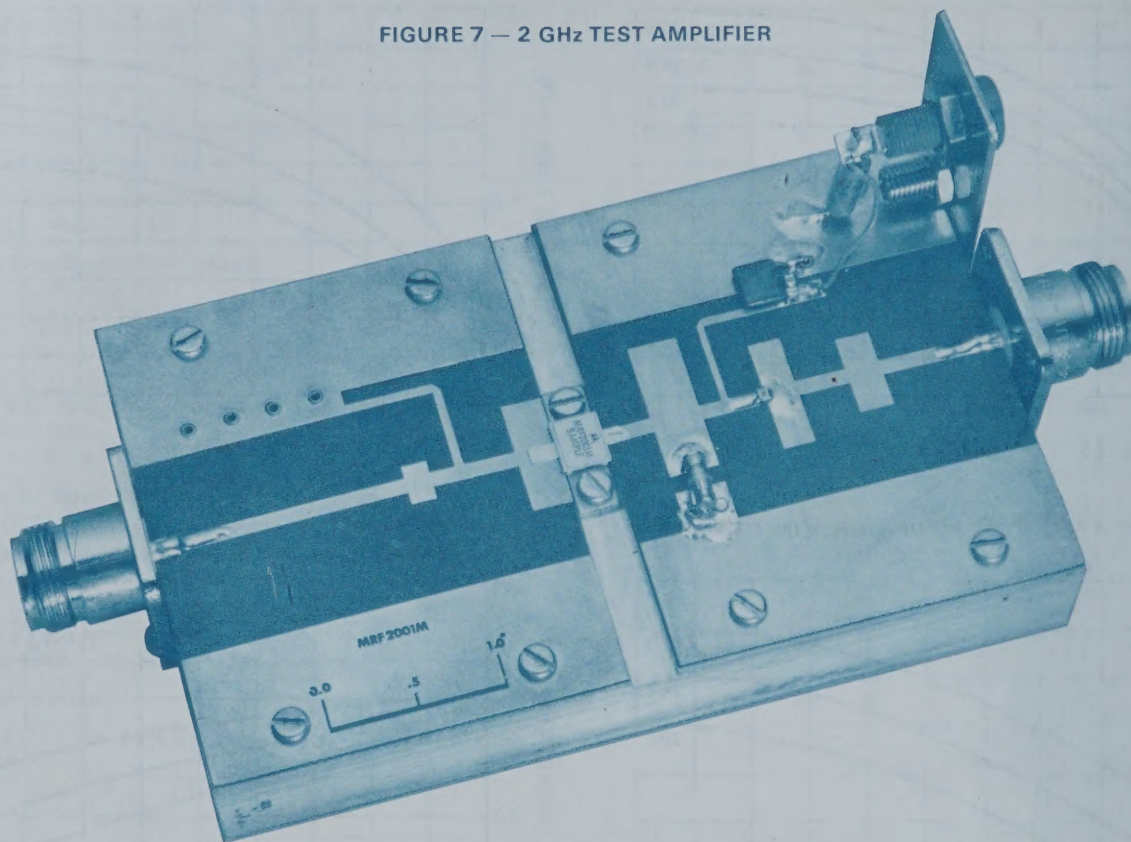
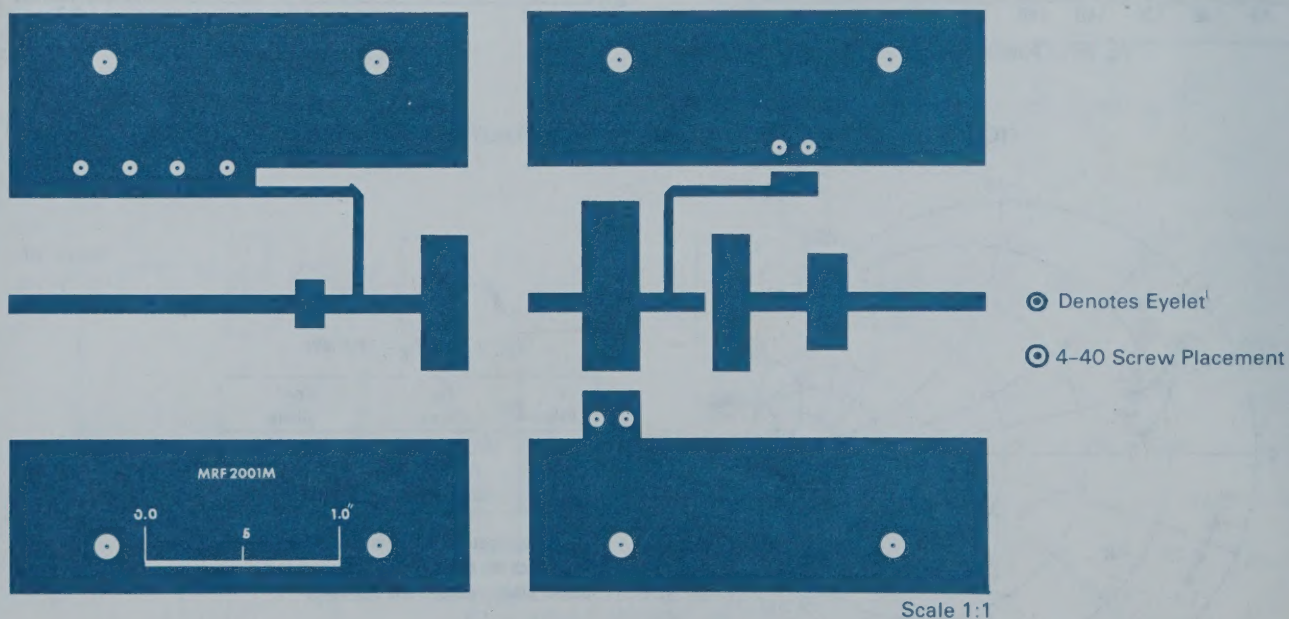


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2.0 GHz TEST CIRCUIT



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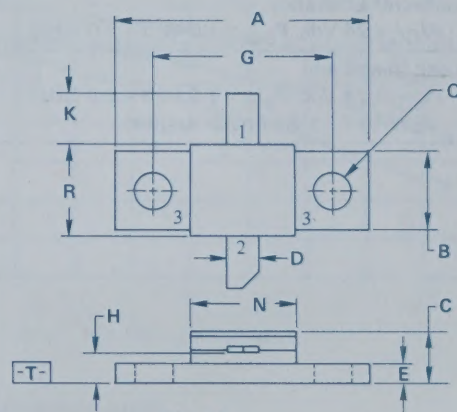
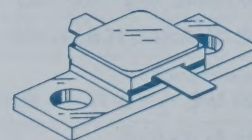
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## MRF2001M

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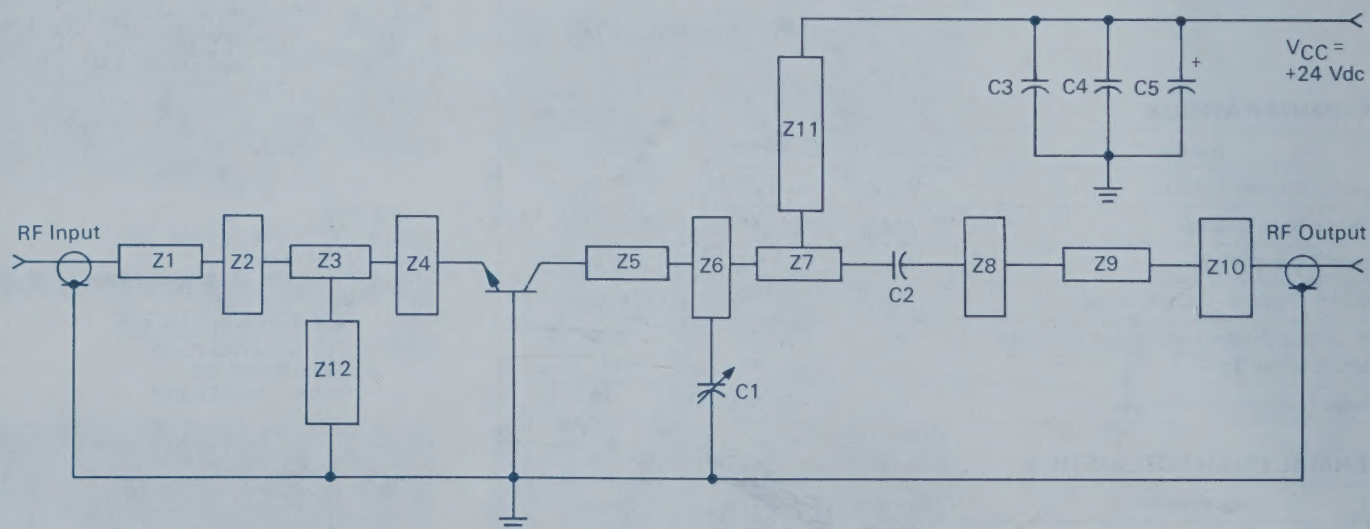
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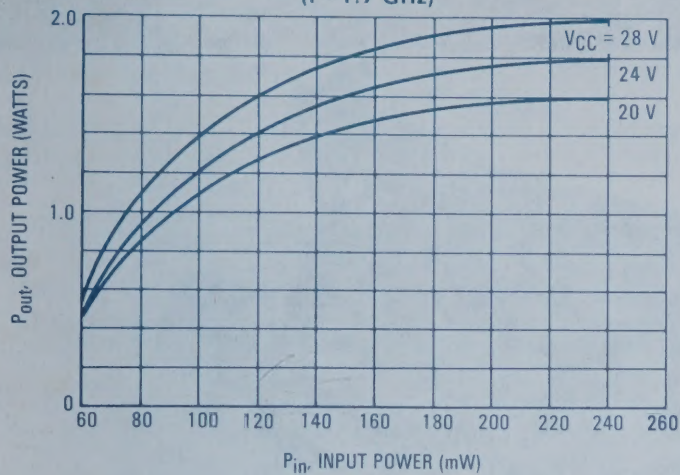


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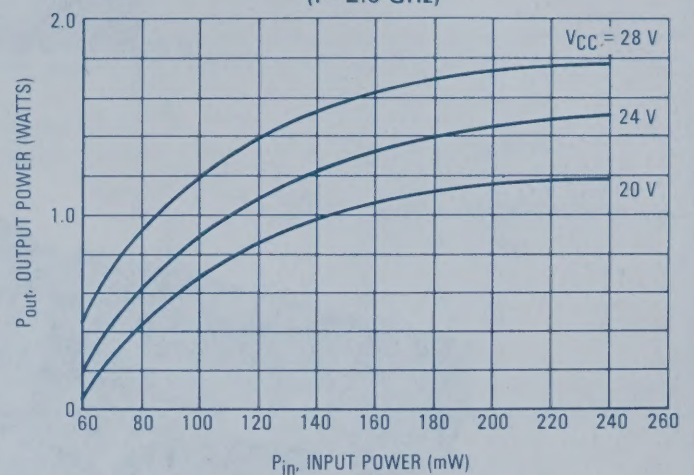


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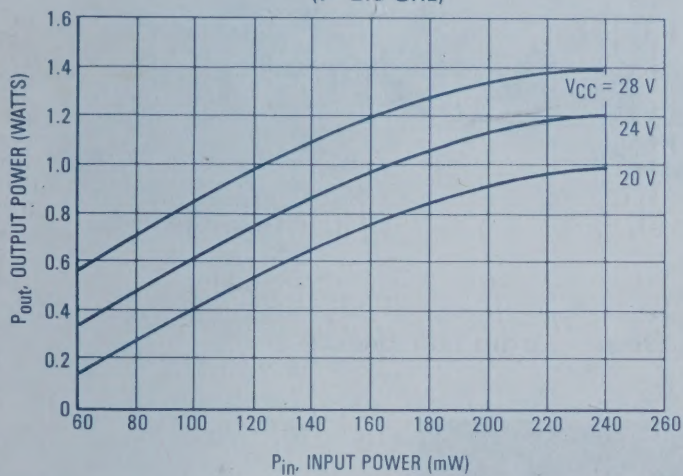


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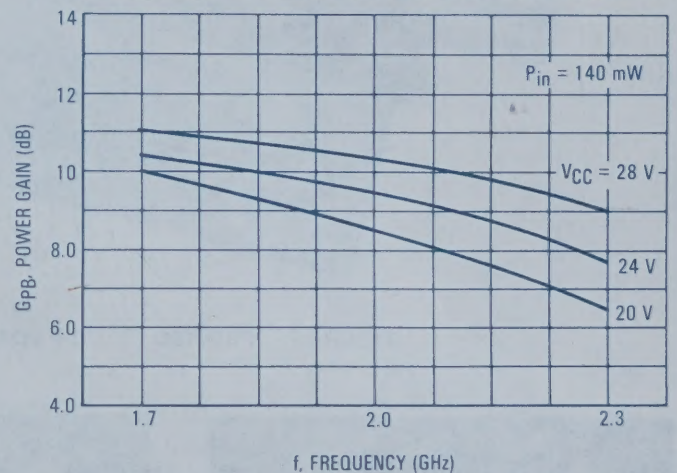
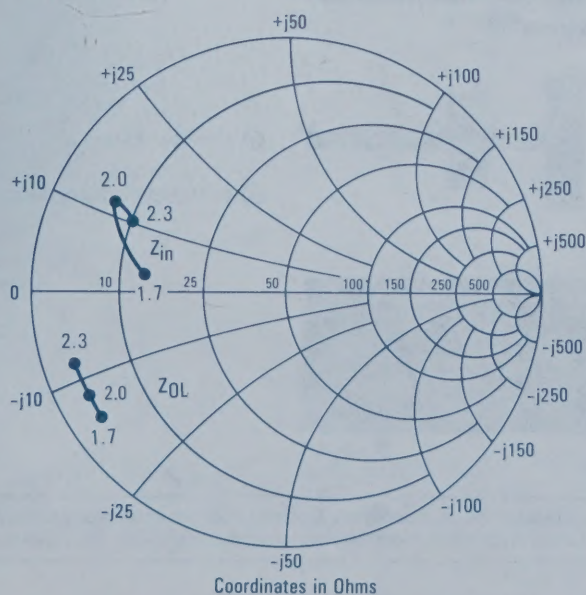


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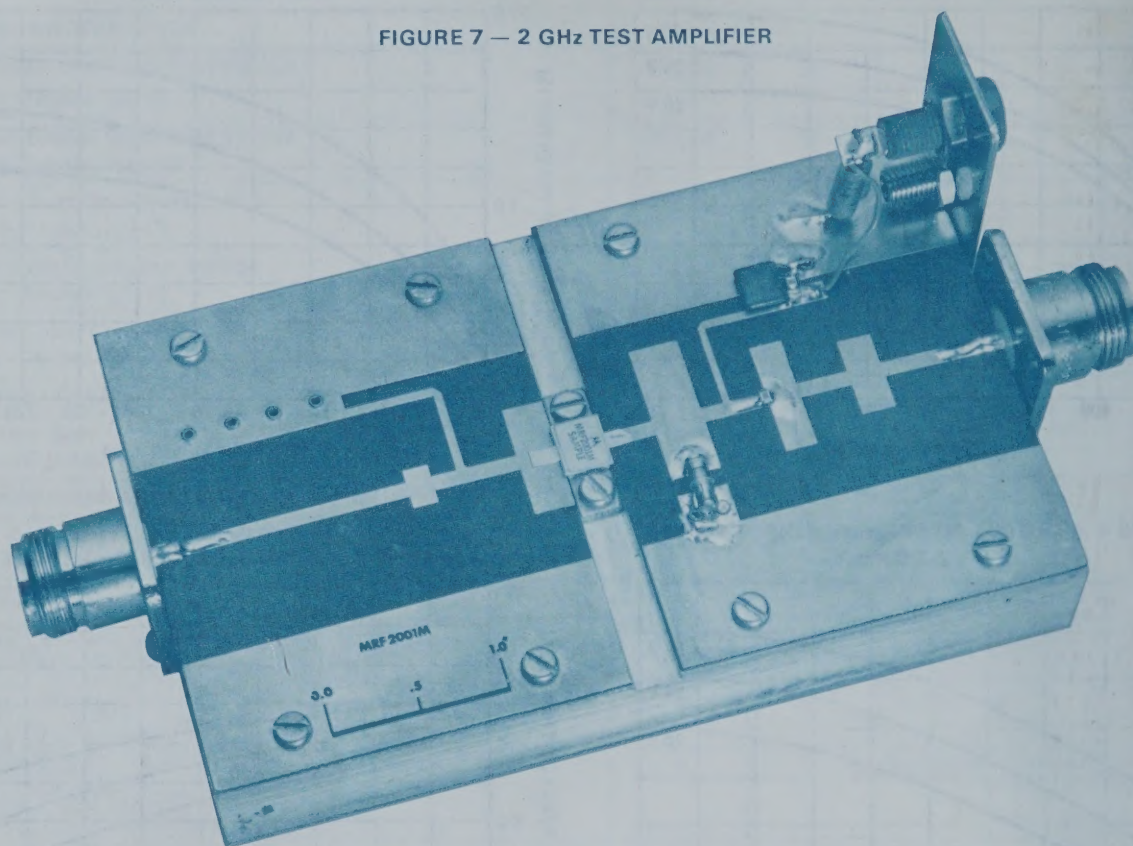
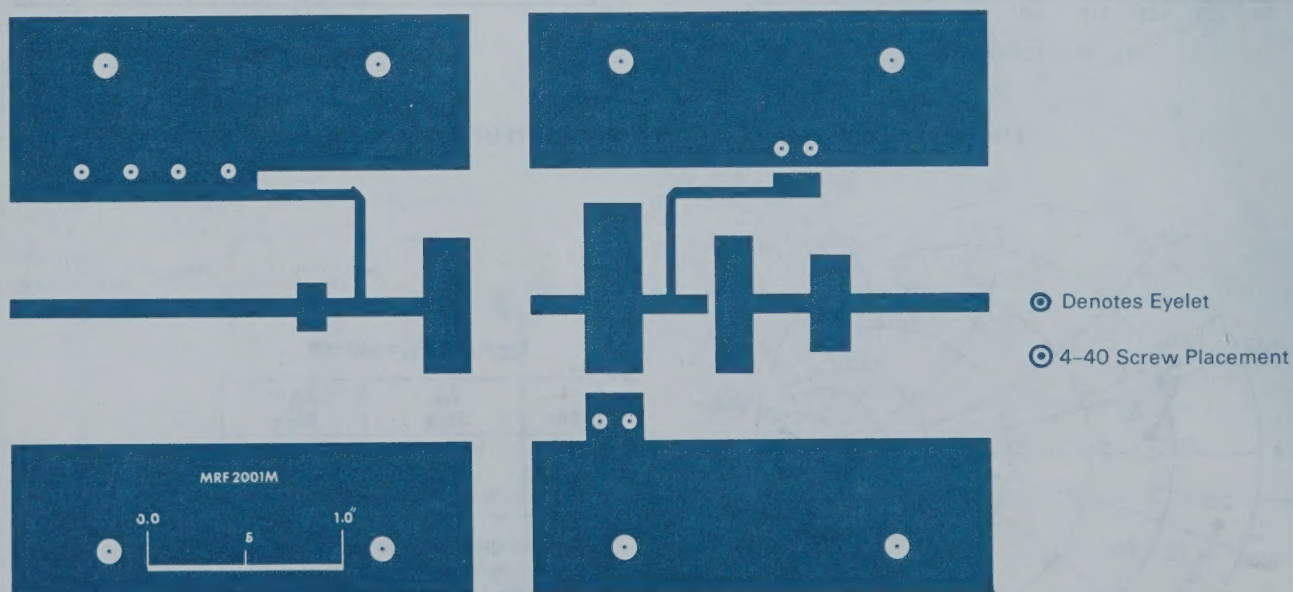


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Scale 1:1

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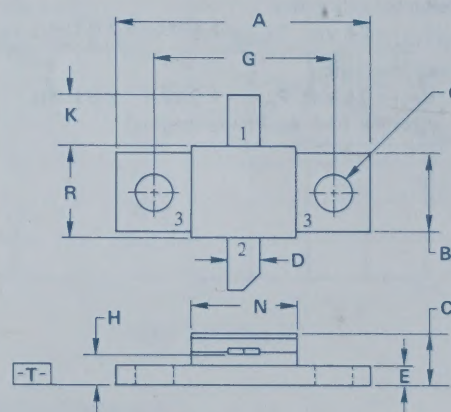
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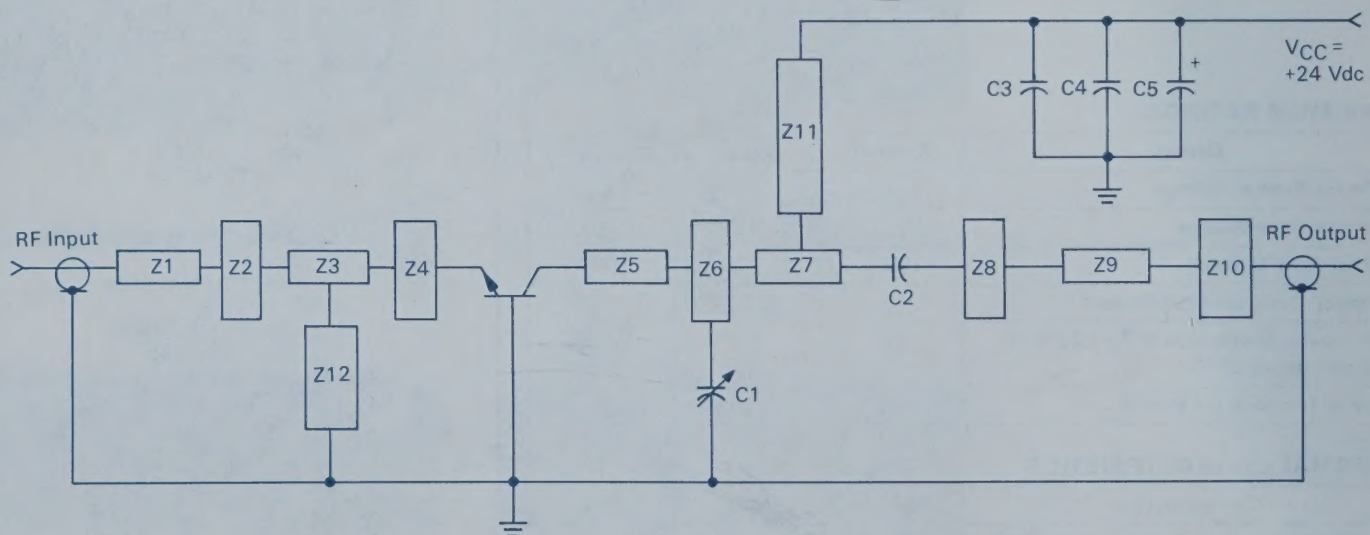
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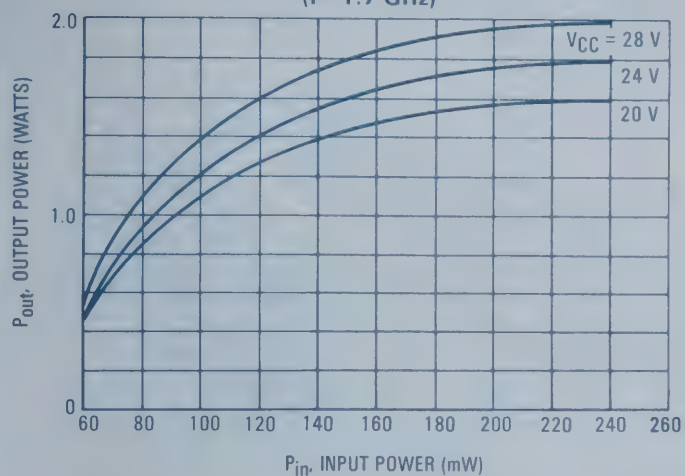
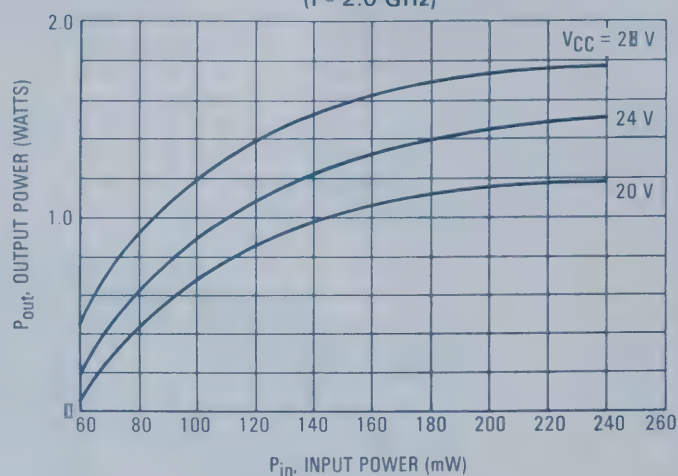
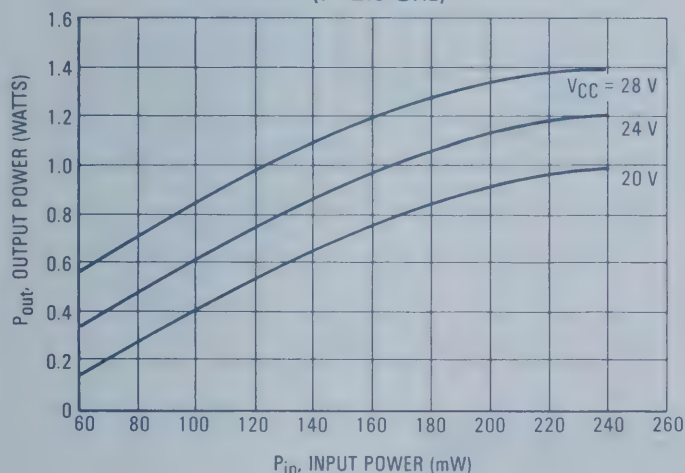
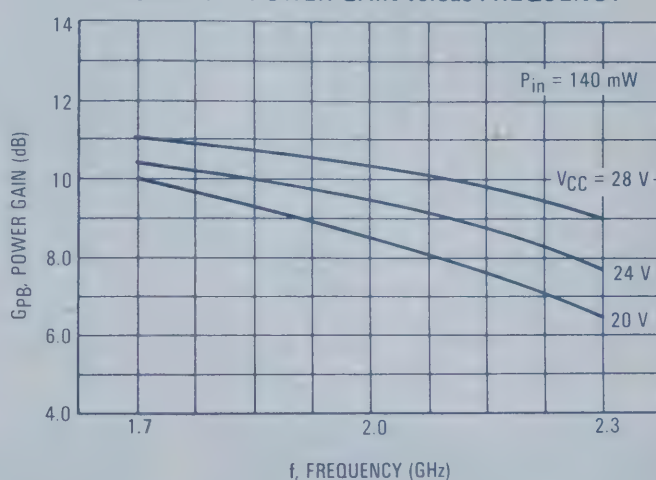
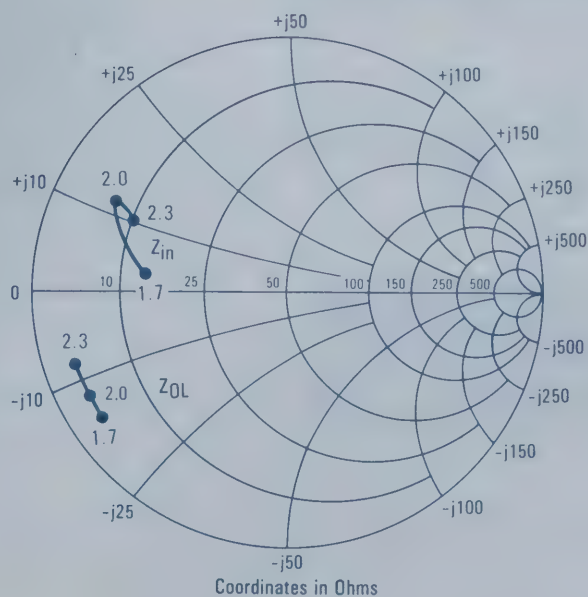
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Collector Efficiency ( $V_{CC} = 24\text{ Vdc}$ , $P_{out} = 1.0\text{ W}$ , $f = 2.0\text{ GHz}$ )	$\eta$	35	40	—	
Load Mismatch ( $V_{CC} = 24\text{ Vdc}$ , $P_{out} = 1.0\text{ W}$ , $f = 2.0\text{ GHz}$ ) VSWR = 10:1 All Phase Angles)	$\psi$	No Degradation in Power Output			

FIGURE 1 — 2.0 GHz TEST CIRCUIT



Z1-Z12 — Microstrip, See Photomaster  
 C1 — 0.6–4.5 pF Johanson 7271  
 C2, C3 — 56 pF Chip Capacitor  
 C4 — 0.1  $\mu\text{F}$   
 C5 — 10  $\mu\text{F}$ , 35 V  
 Board Material — 0.0312" Teflon Fiberglass  
 $\epsilon_r = 2.5 \pm 0.05$



**FIGURE 2 — OUTPUT POWER versus INPUT POWER**  
(f = 1.7 GHz)

**FIGURE 3 — OUTPUT POWER versus INPUT POWER**  
(f = 2.0 GHz)

**FIGURE 4 — OUTPUT POWER versus INPUT POWER**  
(f = 2.3 GHz)

**FIGURE 5 — POWER GAIN versus FREQUENCY**

**FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE**


V<sub>CC</sub> = 24 V, P<sub>in</sub> = 140 mW

f GHz	Z <sub>in</sub> Ohms	Z <sub>OL</sub> * Ohms
1.7	15.5 + j 3.0	4.5 - j15.0
2.0	7.5 + j11.0	4.0 - j12.0
2.3	10.0 + j10.0	3.0 - j 7.0

\*Z<sub>OL</sub> = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



FIGURE 7 — 2 GHz TEST AMPLIFIER

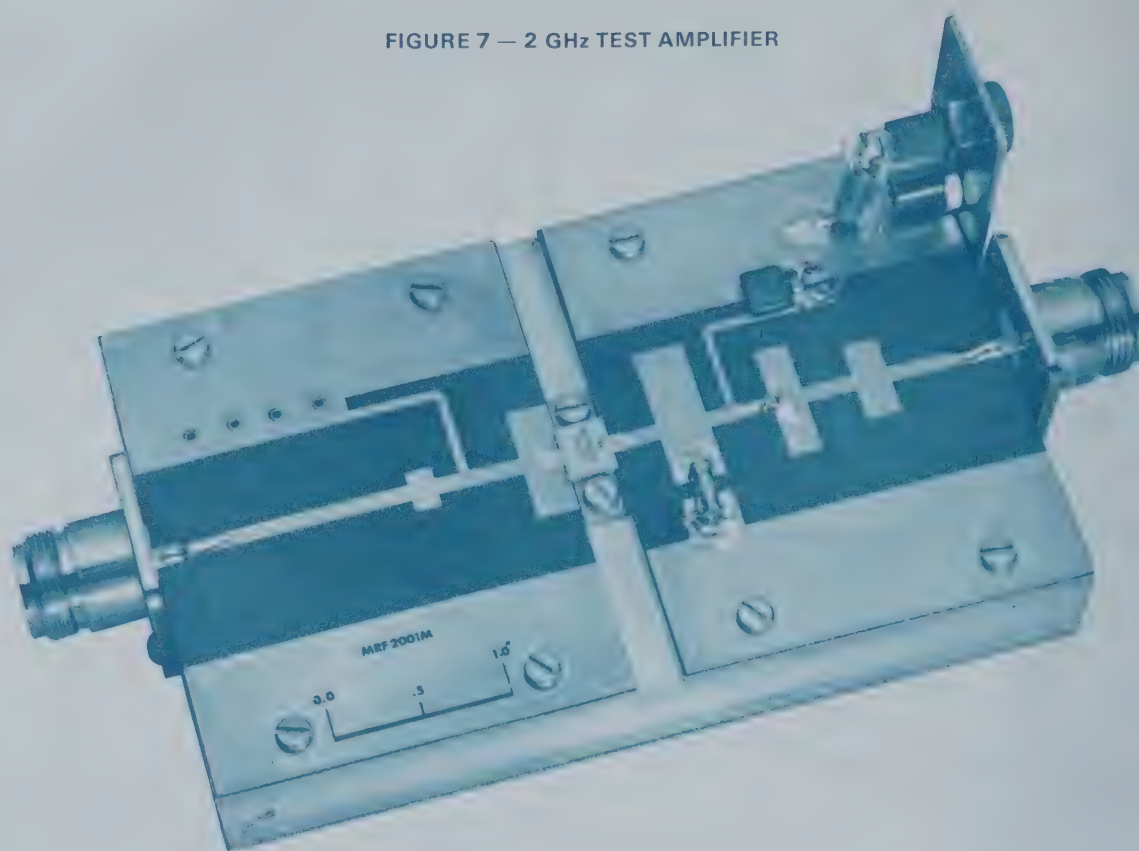
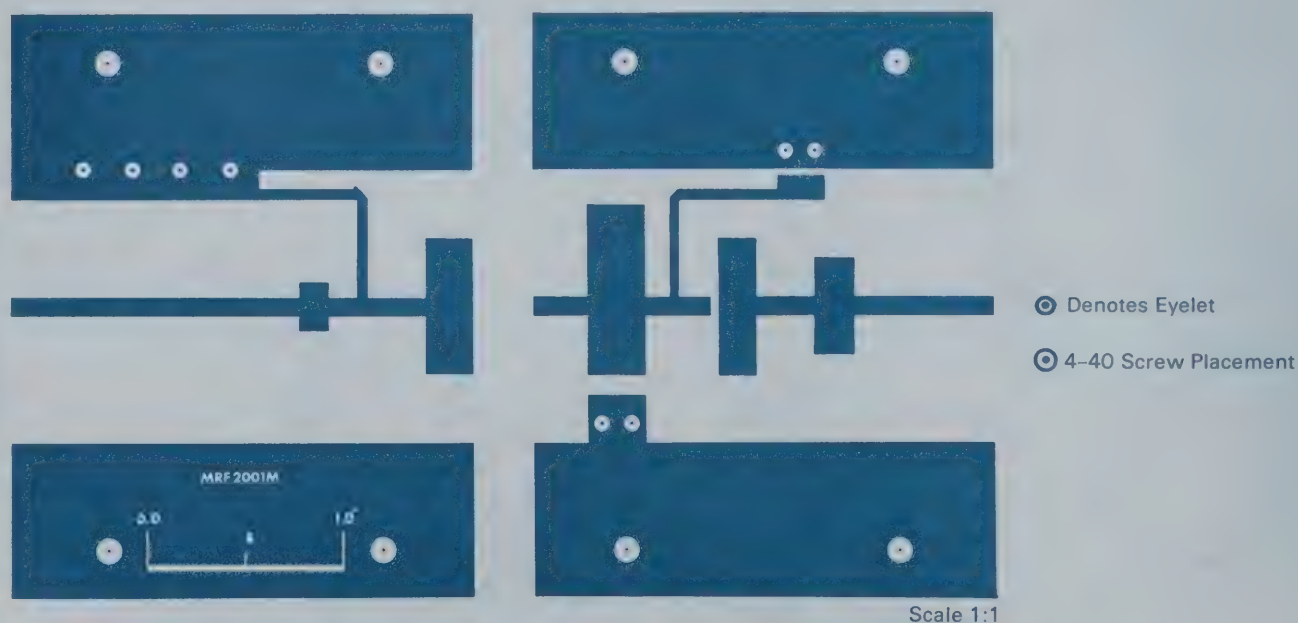


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2.0 GHz TEST CIRCUIT



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**MOTOROLA**

# SEMICONDUCTORS

P.O. BOX 20912 • PHOENIX, ARIZONA 85036

## The RF Line

### NPN SILICON MICROWAVE POWER TRANSISTOR

... designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc  
Output power = 1.0 Watt  
Minimum Gain = 8.5 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CEO}$	20	Vdc
Collector-Base Voltage	$V_{CBO}$	45	Vdc
Emitter-Base Voltage	$V_{EBO}$	4.0	Vdc
Collector-Current — Continuous	$I_C$	250	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above $25^\circ\text{C}$	$P_D$	7.0 40	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +200	$^\circ\text{C}$

### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	$^\circ\text{C}/\text{W}$

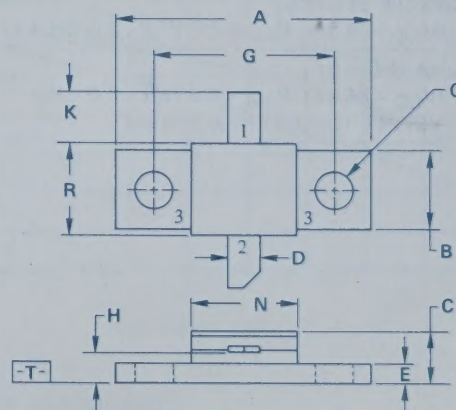
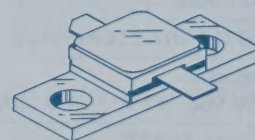
- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

## MRF2001M

1.0 W 2 GHz

### MICROWAVE POWER TRANSISTOR

NPN SILICON



STYLE 1:  
PIN 1. EMITTER  
2. COLLECTOR  
3. BASE

#### NOTES:

1. DIMENSIONS  $\boxed{A}$  AND  $\boxed{B}$  ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:  
 $\boxed{\varnothing 0.13(0.005)} \boxed{M} \boxed{T} \boxed{A} \boxed{B} \boxed{M}$
3.  $\boxed{T}$  IS SEATING PLANE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

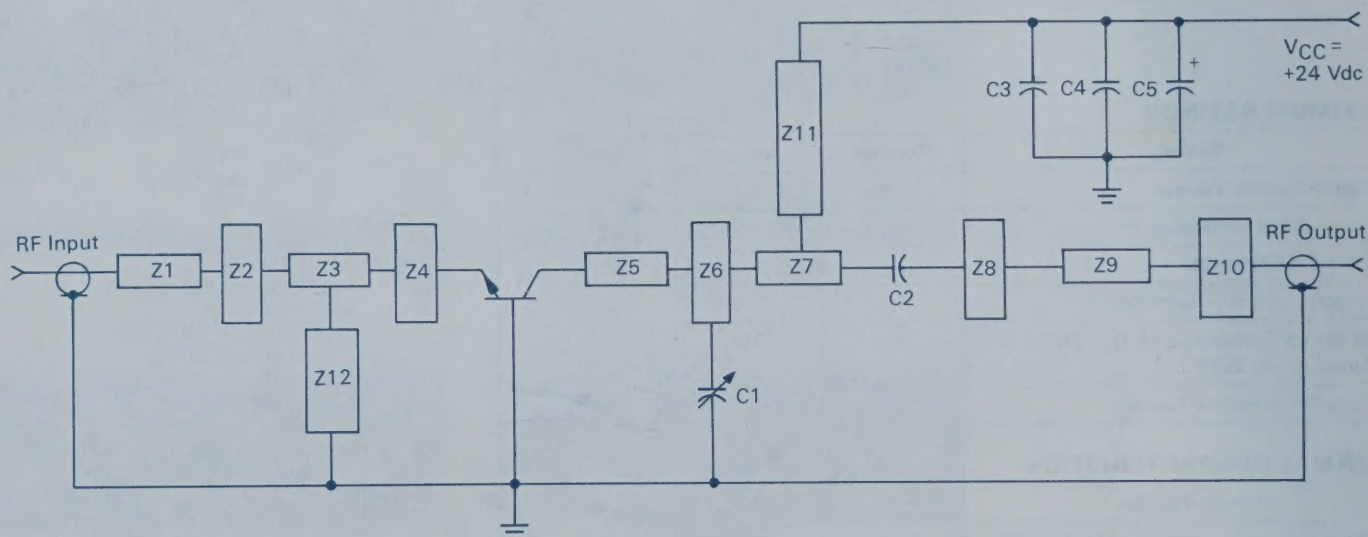
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.22	6.48	0.245	0.255
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Collector-Emitter Breakdown Voltage ( $I_C = 5.0\text{ mAdc}$ , $I_B = 0$ )	$BV_{CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ( $I_C = 5.0\text{ mAdc}$ , $V_{BE} = 0$ )	$BV_{CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ( $I_C = 5.0\text{ mAdc}$ , $I_E = 0$ )	$BV_{CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ( $I_E = 1.0\text{ mAdc}$ , $I_C = 0$ )	$BV_{EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ( $V_{CB} = 28\text{ Vdc}$ , $I_E = 0$ )	$I_{CBO}$	—	—	0.5	mAdc
<b>ON CHARACTERISTICS</b>					
DC Current Gain ( $I_C = 100\text{ mAdc}$ , $V_{CE} = 5.0\text{ Vdc}$ )	$h_{FE}$	10	—	100	—
<b>DYNAMIC CHARACTERISTICS</b>					
Output Capacitance ( $V_{CB} = 24\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )	$C_{ob}$	—	4.0	6.0	pF
<b>FUNCTIONAL TESTS</b>					
Common-Base Amplifier Power Gain ( $V_{CC} = 24\text{ Vdc}$ , $P_{out} = 1.0\text{ W}$ , $f = 2.0\text{ GHz}$ )	$G_{PB}$	8.5	9.5	—	dB
Collector Efficiency ( $V_{CC} = 24\text{ Vdc}$ , $P_{out} = 1.0\text{ W}$ , $f = 2.0\text{ GHz}$ )	$\eta$	35	40		
Load Mismatch ( $V_{CC} = 24\text{ Vdc}$ , $P_{out} = 1.0\text{ W}$ , $f = 2.0\text{ GHz}$ , VSWR = 10:1 All Phase Angles)	$\psi$	No Degradation in Power Output			

FIGURE 1 — 2.0 GHz TEST CIRCUIT



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 C5 — 10  $\mu\text{F}$ , 35 V  
 Board Material — 0.0312" Teflon Fiberglass  
 $\epsilon_r = 2.5 \pm 0.05$



FIGURE 2 — OUTPUT POWER versus INPUT POWER  
( $f = 1.7$  GHz)

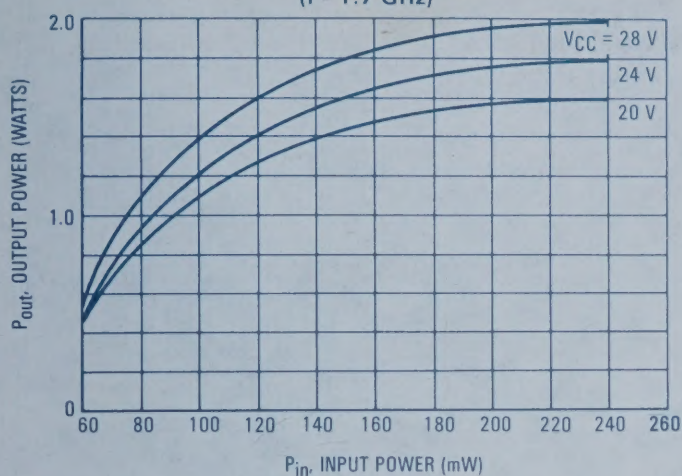


FIGURE 3 — OUTPUT POWER versus INPUT POWER  
( $f = 2.0$  GHz)

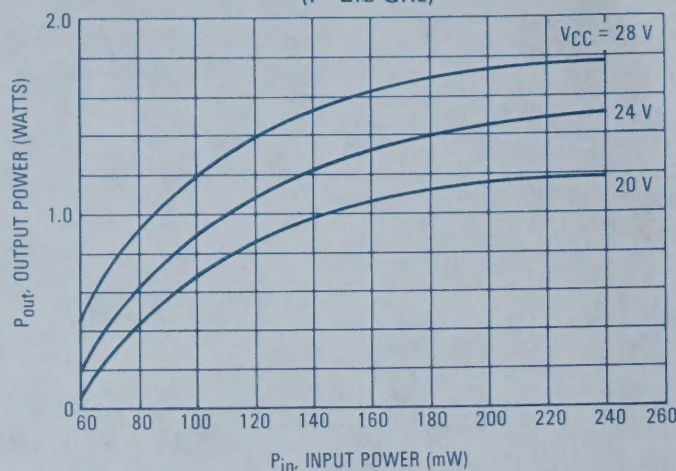


FIGURE 4 — OUTPUT POWER versus INPUT POWER  
( $f = 2.3$  GHz)

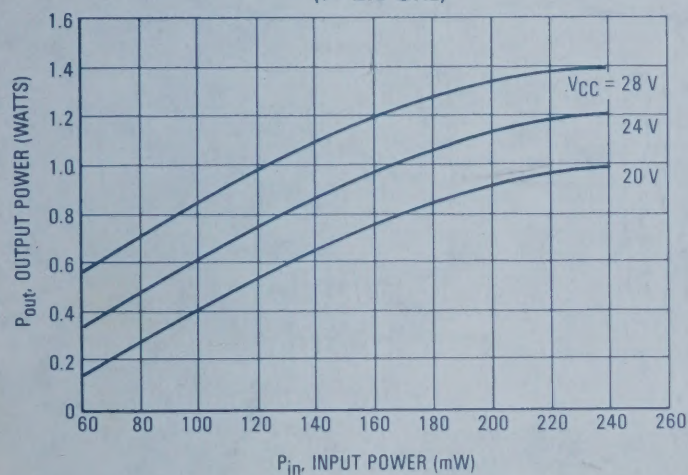


FIGURE 5 — POWER GAIN versus FREQUENCY

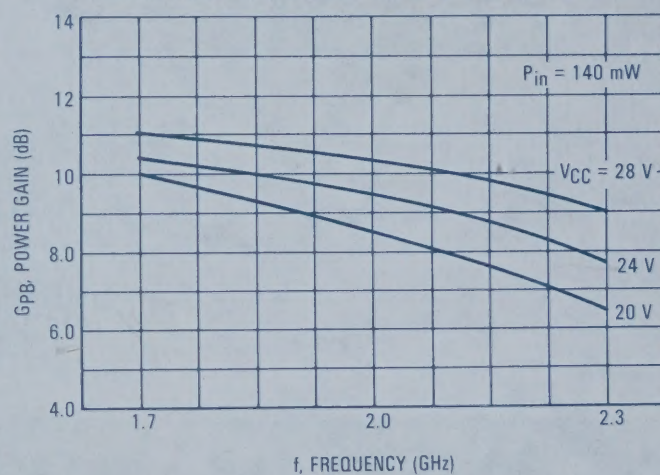
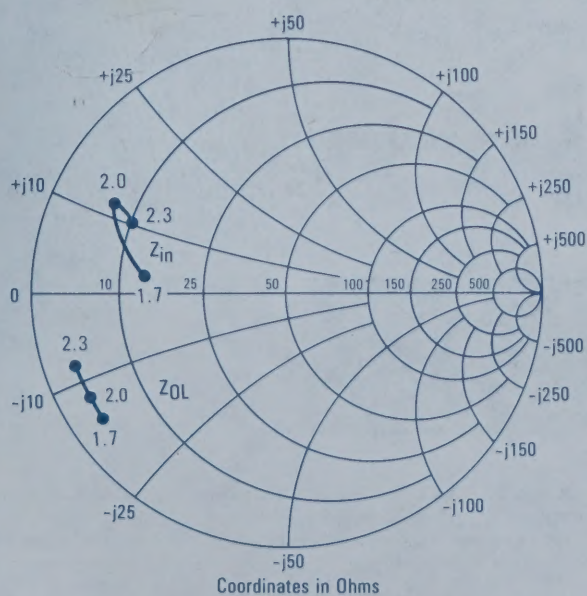


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



$V_{CC} = 24$  V,  $P_{in} = 140$  mW

$f$ GHz	$Z_{in}$ Ohms	$Z_{OL}^*$ Ohms
1.7	$15.5 + j 3.0$	$4.5 - j 15.0$
2.0	$7.5 + j 11.0$	$4.0 - j 12.0$
2.3	$10.0 + j 10.0$	$3.0 - j 7.0$

\* $Z_{OL}$  = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



FIGURE 7 — 2 GHz TEST AMPLIFIER

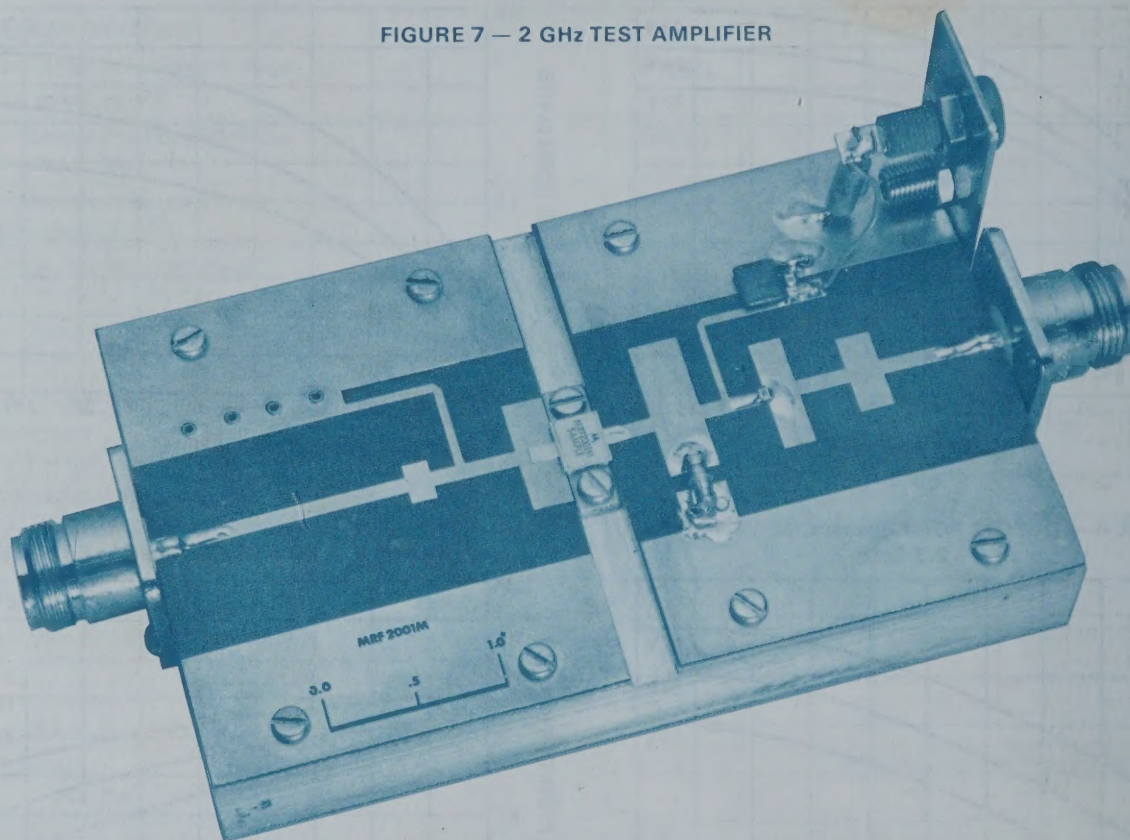
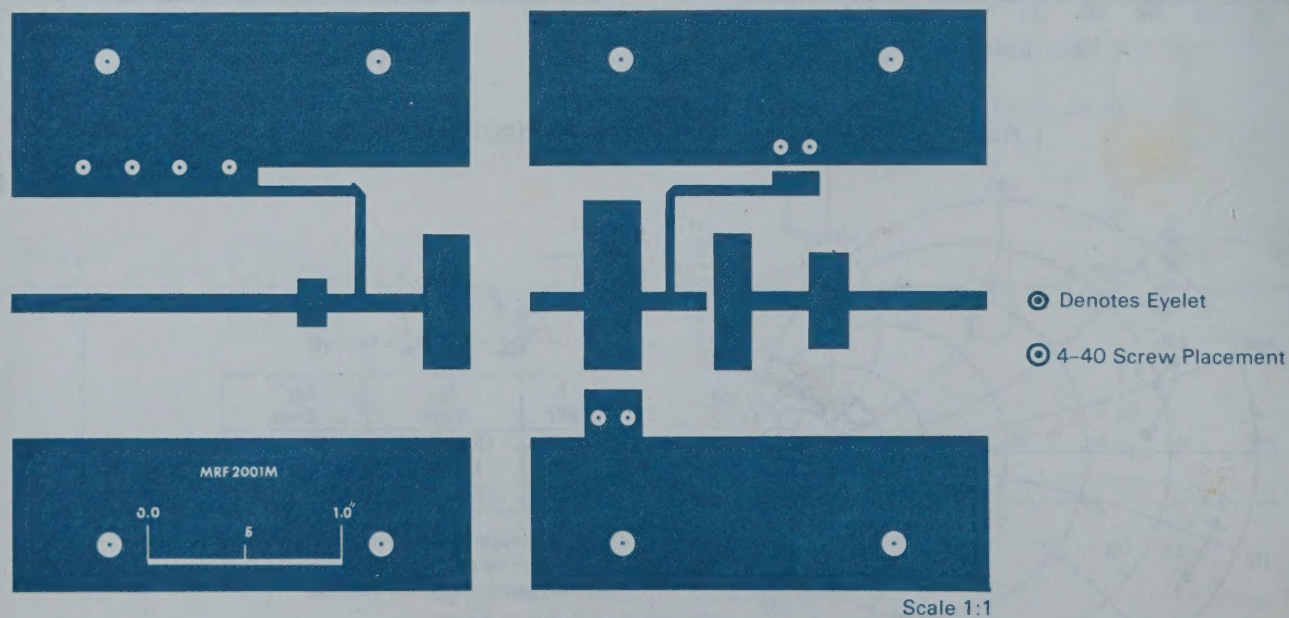


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2.0 GHz TEST CIRCUIT



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